



*Better Buildings Residential Network  
Peer Exchange Call Series*

*Smart Diagnostics – New Advances in the Efficiency Field*

January 27, 2022

# Agenda and Ground Rules

- Agenda Review and Ground Rules
- Opening Poll
- Residential Network Overview and Upcoming Call Schedule
- Featured Speakers
  - **Christian Valoria**, Pacific Northwest National Laboratory
  - **Will D'Arrigo**, ICF International
  - **Drew Eckman**, Bluon
  - **Clifton Beck**, Bluon
- Open Discussion
- Closing Poll and Announcements

## Ground Rules:

1. **Sales of services and commercial messages are not appropriate** during Peer Exchange Calls.
2. Calls are a safe place for discussion; **please do not attribute information to individuals** on the call.

*The views expressed by speakers are their own, and do not reflect those of the Dept. of Energy.*

# Better Buildings Residential Network

## Join the Network

### Member Benefits:

- Recognition in media, social media and publications
- Speaking opportunities
- Updates on latest trends
- Voluntary member initiatives
- One-on-One brainstorming conversations

### Commitment:

- Members only need to provide *one number*: their organization's number of residential energy upgrades per year, or equivalent.

### Upcoming Calls (2<sup>nd</sup> & 4<sup>th</sup> Thursdays):

- *2/10: Secrets from the Most Successful Residential Efficiency Programs*
- *2/27: It's Not About Energy, It's About Comfort – Addressing the Reality*

Peer Exchange Call summaries are posted on the Better Buildings [website](#) a few weeks after the call

For more information or to join, for no cost, email [bbresidentialnetwork@ee.doe.gov](mailto:bbresidentialnetwork@ee.doe.gov), or go to [energy.gov/eere/bbrn](http://energy.gov/eere/bbrn) & click Join



**Christian Valoria**  
*Pacific Northwest National Laboratory*



# Smart Tools for Efficient HVAC Performance (STEP) Campaign

**Pacific Northwest National Laboratory**

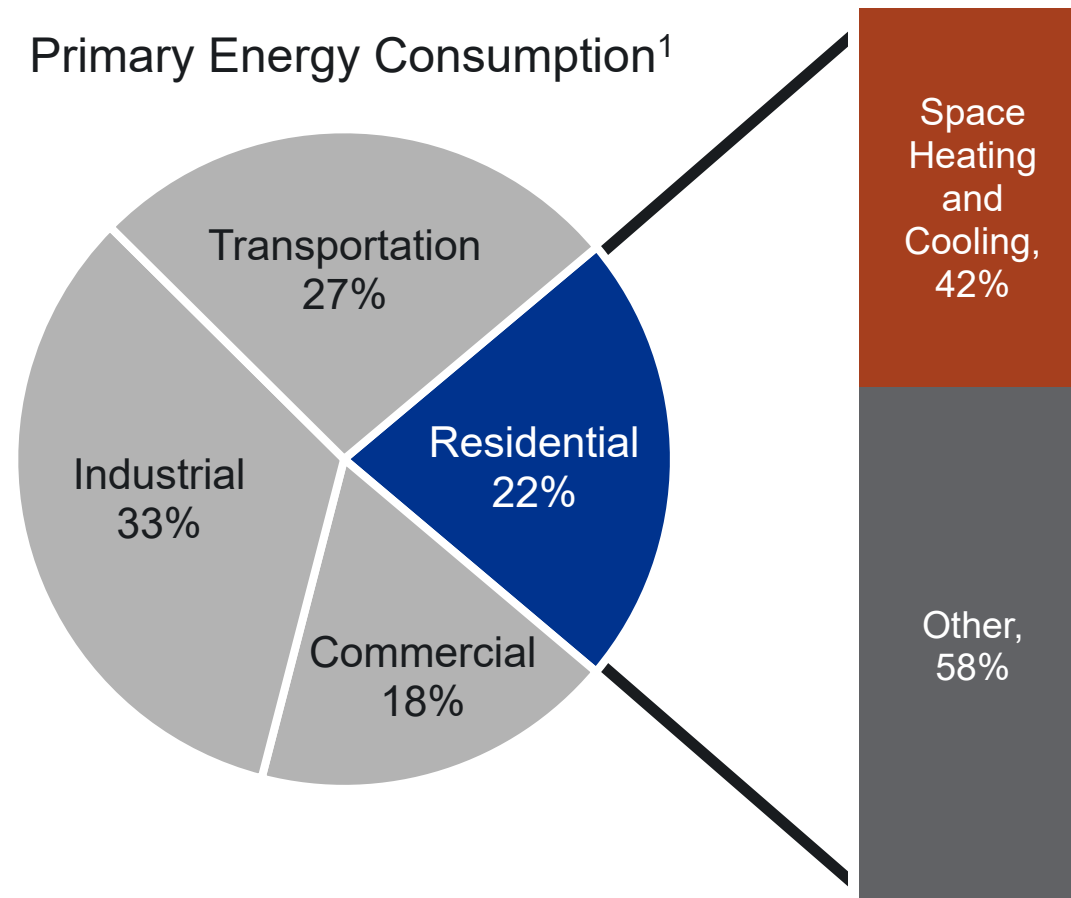
Christian Valoria



# Residential HVAC in the United States

- Nearly 10% of all primary energy consumption is used to heat and cool our homes!
- Projected 59% growth in residential air conditioning consumption from 2019 to 2050, largest increase among all end-uses.<sup>2</sup>
- Large opportunity for energy efficiency
- Large opportunity for energy waste
- We want to make sure that 10% we have influence over is as efficient as possible

Primary Energy Consumption<sup>1</sup>

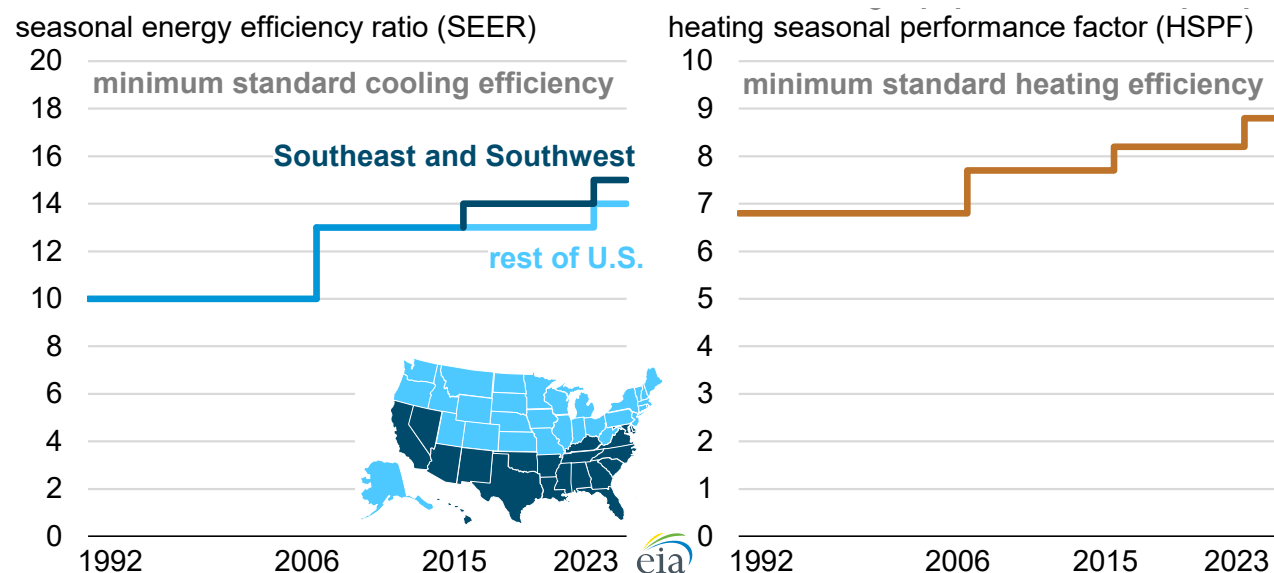


Source:

1. EIA Annual Energy Outlook 2020
2. EIA. EIA projects air-conditioning energy use to grow faster than any other use in buildings. Accessed Nov 2021. Available at: <https://www.eia.gov/todayinenergy/detail.php?id=43155>



# HVAC Efficiency Over the Years



**Figure:** Performance standards for residential central air-conditioning equipment and heat pumps<sup>1</sup>

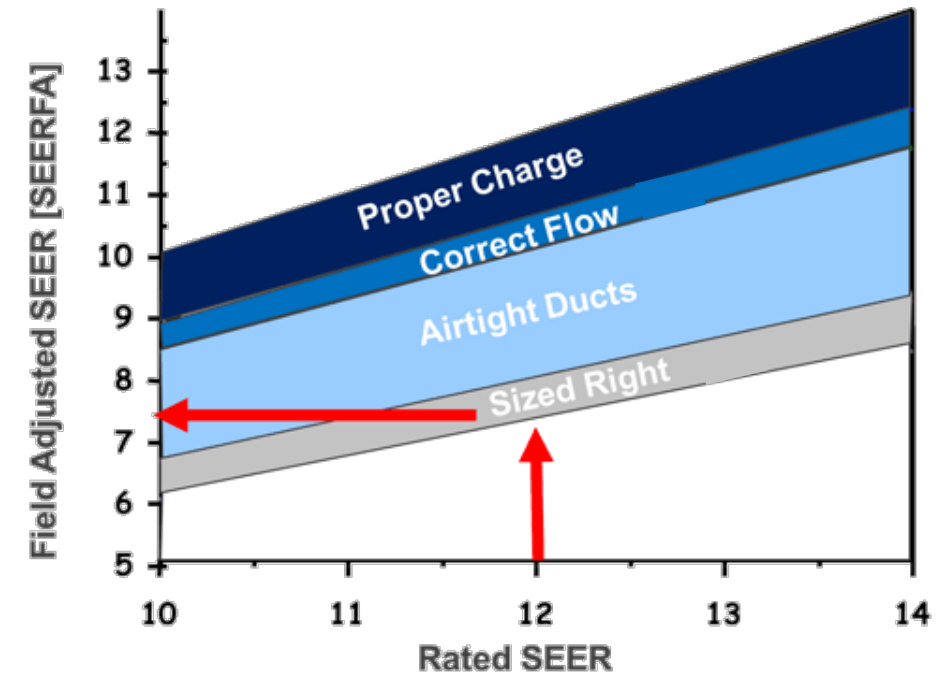
- Code- and innovation-driven efficiency improvements
- 2022 ENERGY STAR Most Efficient, 28 SEER!
- Heat pumps move heat = More efficient heating

Source:

1. EIA. Efficiency requirements for residential central AC and heat pumps to rise in 2023. Accessed Nov 2021. Available at: <https://www.eia.gov/todayinenergy/detail.php?id=40232>

# Improper Installation and HVAC Faults

- Improper installation of central air conditioning (CAC) and air-source heat pump (ASHP) systems results in **decreased performance, energy waste, and reliability issues**:
  - At least **one energy wasting fault** in **70-90% of homes**<sup>2</sup>
  - At least **20% of CAC/ASHPs** experience failure due to improper installation<sup>2</sup>
  - Estimated **9% energy waste** due to decreased CAC/ASHP performance due to inadequate airflow and improper refrigerant charge<sup>3</sup>



**Figure:** Theoretical field adjusted SEER caused by installation and sizing issues<sup>1</sup>

Source:

1. EPA ENERGY STAR. Sponsoring an ENERGY STAR Verified HVAC Installation Program. Accessed Sep 2021. Available at: [https://www.energystar.gov/campaign/heating\\_cooling/esvi/benefits\\_hvac\\_contractors/sponsoring\\_esvi](https://www.energystar.gov/campaign/heating_cooling/esvi/benefits_hvac_contractors/sponsoring_esvi)
2. EERE, 2019. [Residential HVAC Installation Practices: A Review of Research Findings](#)
3. Winkler et al. 2020. Impact of installation faults in air conditioners and heat pumps in single-family homes on U.S. energy usage. Applied Energy, Volume 278

# So, what's the fix?



# Quality Residential HVAC



## Smart Diagnostic Tools



Sizing

Selection

Design

Installation

Commissioning

Maintenance

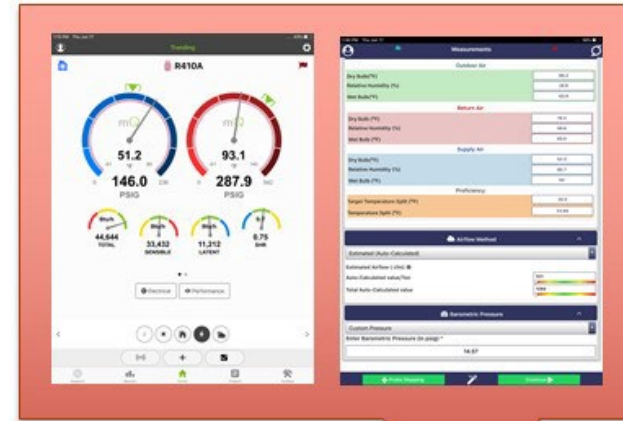


# Residential HVAC Diagnostics



**Traditional Diagnostics**

## **Technology-assisted Diagnostics**



# Smart Diagnostic Tools Overview

## Description

- Bluetooth enabled sensors installed temporarily by a technician. Connecting to application on local device provides HVAC fault detection and diagnostics. Options for storing diagnostic data in cloud to access in future.

## Key Points

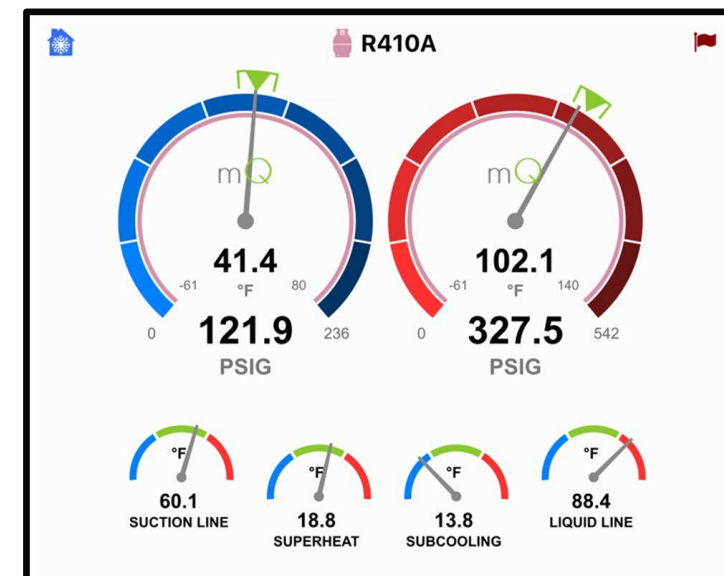
- One technician and tool set can provide fault detection for many HVAC systems
- Wide-range of available measurements (air temperature and humidity, refrigerant, power, vacuum gauge, airflow)

## Current State of Technology

- Available products in the market
- Ongoing DOE sponsored campaign

## Example Products / Manufacturers

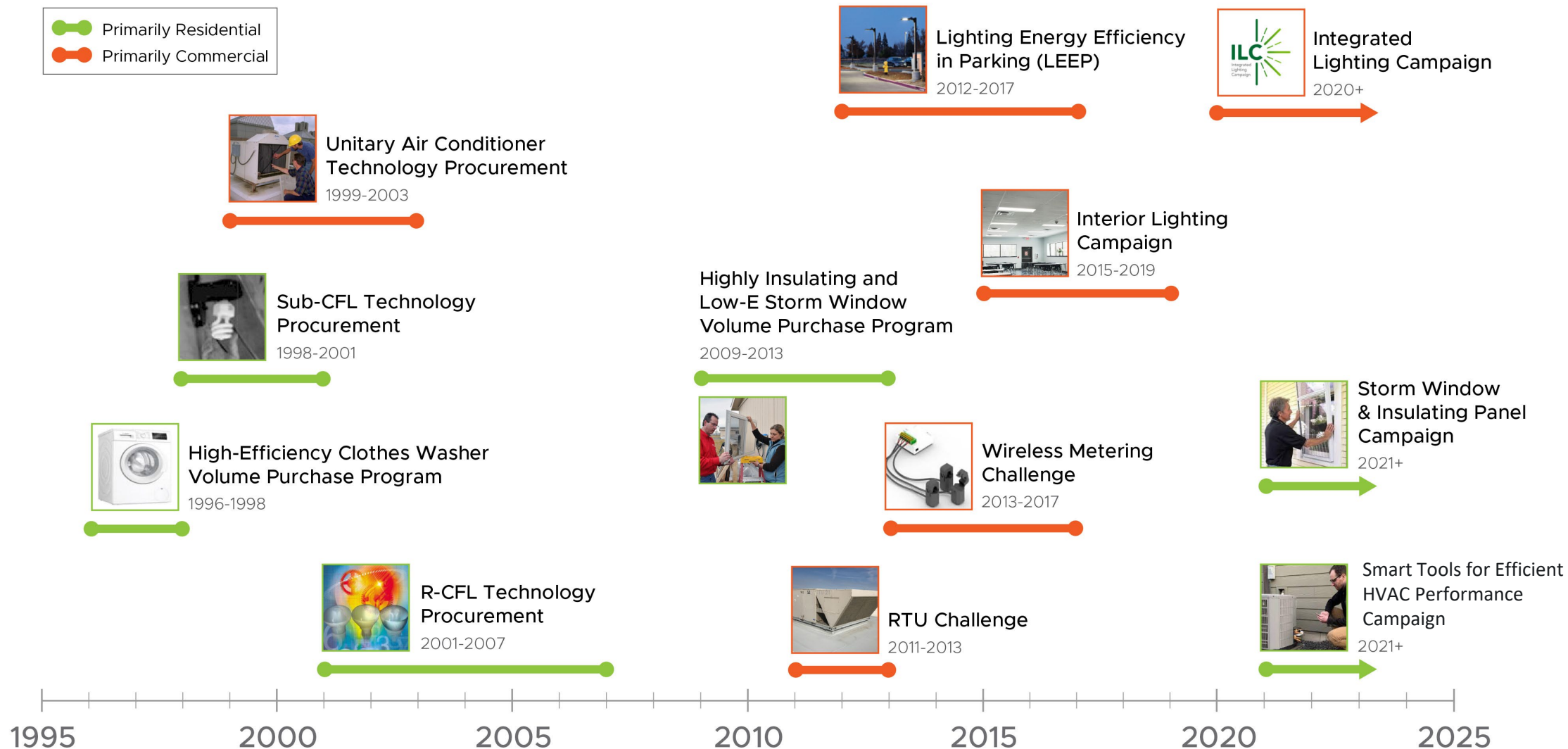
- MeasureQuick (application only); iManifold (application and sensors)
- Fieldpiece, Parker Sporlan, Testo, BluVac, Redfish





# Technology Campaigns and Challenges Led by PNNL

- Primarily Residential
- Primarily Commercial



# Smart Tools for Efficient HVAC Performance Campaign

Working in partnership to help ensure heat pumps and central air conditioners operate efficiently and maintain optimal performance over time, reducing contractor callbacks and delivering comfort, energy savings, and low carbon heating and cooling to homeowners

## Why Smart Diagnostic Tools?

- They allow technicians to quickly commission new heat pump and central air conditioning systems and identify faults in existing systems – improving the quality of installation and reducing energy waste due to faults
- Automated Fault Detection and Diagnostic (AFDD) systems and on-board diagnostics are currently only available in very high-end equipment for reliability, not energy efficiency

## Why the Campaign?

- A national one-stop-shop for unbiased information and resources to speed adoption of smart diagnostic tools
- Provides access to key resources
- Provides recognition for partner successes

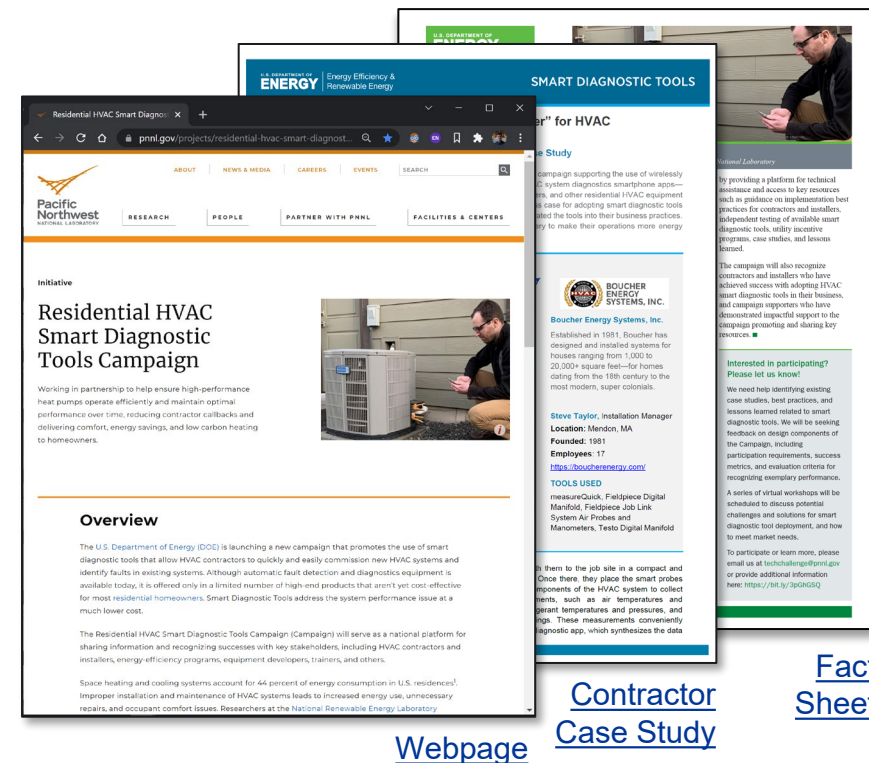
# Smart Tools for Efficient HVAC Performance Campaign

- Developed resources to support overcoming barriers to adoption
  - STEP fact sheet
  - Contractor case study
  - Mass Save case study – in progress
  - Smart diagnostic tool training material – in progress
- Recruiting Campaign “Early Adopters”
- Campaign webpage, fully-functional Campaign website in progress

Interested in learning more about the STEP campaign or how your organization can participate?

Visit: <https://www.pnnl.gov/projects/residential-hvac-smart-diagnostic-tools-campaign>

Contact: [christian.valoria@pnnl.gov](mailto:christian.valoria@pnnl.gov)



## Organizing Committee





# Thank you

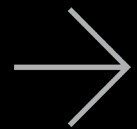
Christian Valoria  
[christian.valoria@pnnl.gov](mailto:christian.valoria@pnnl.gov)





**Will D'Arrigo**  
*ICF International*





## Residential Heat Pump Offerings

**Sponsors of Mass Save®**

William D'Arrigo  
Program Manager



01/27/2022

# Agenda

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- Mass Save® Portfolio
  - Mass Save Sponsors
  - Mass Save Offerings
- Heating and Cooling
  - HVAC Contractor Training
    - Energy Efficiency Learning Center
  - Mobile App
  - HVAC Contractor Response
- Q&A



# → Mass Save® Portfolio

Bringing simple energy savings to Massachusetts





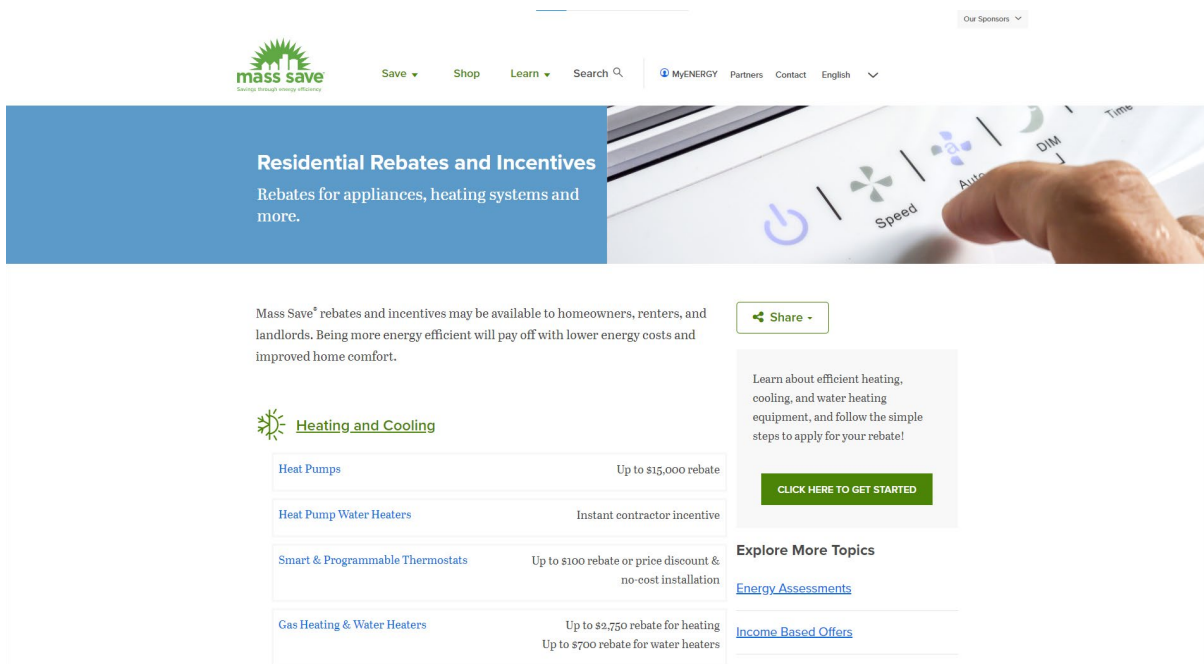
# About Mass Save®

The Sponsors of Mass Save make good happen for Massachusetts.

- The local electric and natural gas utilities and energy efficiency service provider are taking strides in energy efficiency: Berkshire Gas, Cape Light Compact, Eversource, Liberty Utilities, National Grid and Unitil.
- As one, they form Mass Save®, with the common goal of helping residents and businesses across Massachusetts save money and energy, leading the state to a clean and energy efficient future.



# Mass Save Offerings & Massachusetts Priorities



The screenshot shows the Mass Save website. At the top is the Mass Save logo with the tagline "Saving through energy efficiency". Navigation links include Save, Shop, Learn, Search, MyENERGY, Partners, Contact, and English. A blue banner highlights "Residential Rebates and Incentives" for appliances, heating systems, and more. Below this, a section titled "Heating and Cooling" lists several rebate programs:

Program	Rebate/Incentive
Heat Pumps	Up to \$15,000 rebate
Heat Pump Water Heaters	Instant contractor incentive
Smart & Programmable Thermostats	Up to \$100 rebate or price discount & no-cost installation
Gas Heating & Water Heaters	Up to \$2,750 rebate for heating Up to \$700 rebate for water heaters

Additional features include a "Share" button, a "CLICK HERE TO GET STARTED" button, and links to "Explore More Topics" such as Energy Assessments and Income Based Offers. A background image shows a hand adjusting a thermostat.

- **Equity.** Equitable program investments that ensure weatherization and electrification of homes and businesses in environmental justice communities and low-moderate income households;
- **Weatherization.** Significantly increasing the number of buildings retrofitted and weatherized each year;
- **Electrification.** Significantly ramping up electrification of existing buildings through heat pump goals that set the Commonwealth on a path to achieving one million homes and 300–400 million square feet of commercial buildings using electric heat pump for space heating by 2030;
- **Reduce Fossil Fuel Incentives.** Eliminating measures that increase the use of natural gas for space heating, including those associated with combined heat and power or fuel cells, since they are not consistent with the GHG emission reduction goals and phase out fossil fuel incentives aligned with the Interim 2030 CECP policy recommendations; and
- **Workforce.** Significantly increasing workforce development investments through coordination with the Massachusetts Clean Energy Center, to increase diversity and expand the workforce necessary to achieve our GHG goals and provide economic opportunities.

# → Heating and Cooling



# Energy Efficiency Learning Center

- The Mass Save Heating & Cooling Learning Center offers a growing selection of trainings and resources.
- You can browse courses, add them to your course list and undertake trainings on your own schedule.
- Mass Save is excited to offer this continued learning platform for Participating Contractors.
- Courses offered
  - ASHP Sizing Design Intro
  - ASHP Sizing Design Tech
  - Selling Heat Pumps & Value Proposition
  - Customer Service
  - Weatherization 101
  - Installation Best Practices

The screenshot shows the user interface of the Mass Save Heating & Cooling Learning Center. At the top, there is a green header with the Mass Save logo, a search bar for enrolled courses, and navigation links for Dashboard, My Courses, and My Live Sessions. A 'Download Training History' link is also present. Below the header, a large green banner welcomes the user back and provides information about tool reimbursements. A 'Recent Activity' section on the left lists recent actions like completing a survey and launching a course. The main content area displays two course cards: 'Tool reimbursement\_ Receipt Upload\_2021' (In Progress, 1 Module, 0% completion) and 'Mass Save® Heat Pump Installer Network Participation' (Not Started, 4 Modules, 0% completion). Both cards include progress bars and buttons to Resume or Start the course.

# Mobile app and Emerging Tech

The training then zeroes in on all the useful functions of the mQ app and how it can be used. Contractors are trained to perform these testing procedures to ensure proper installation and operation of equipment and systems, which gives your company a real edge on the competition by providing better service to your customers.



In addition to other benefits of participating in the Heat Pump Installer Network, completing measureQuick training makes contractors eligible to receive incentives for installation and verification work as well as reimbursements for training and diagnostic tool purchases. Incentives include:

\$130 for measureQuick (mQ) submissions

\$250 for downsizing

\$2CFM (max \$600) for duct sealing.

# Contractor Response

- Overall response - Positive
- Successes
  - Ease of access
  - Improved workflow
  - Reduced data entry
  - Diagnostic improvements
- Challenges
  - Learning new equipment
  - Field support
  - Wi-Fi connectivity

The screenshot displays the Mass Save website interface. At the top, there is a green header with the Mass Save logo and a search bar labeled "Search for courses". Below the header, a navigation bar includes a "Back to Catalog" button and tabs for "Description", "Content", and "Reviews". The main content area shows the course title "Air Conditioner and Heat Pump High Performance Tune-up" with details: "Content 7 Modules", "Course Length 1 hour", "Rating ★★★★★ 170 Reviews", and "Reviewer/Instructor Traci Synatschk". A prominent "Enroll" button is visible. To the right, the "Reviews" section lists four reviews from users Robert, Phil, Will, and Rob, all with 5-star ratings and dates from January 2022. Below the course details, an "About" section provides information about browsing and searching the course catalog.

mass save

Search for courses

Back to Catalog

Description Content **Reviews**

> Catalog > Courses > Air Conditioner and Heat Pump High Performance Tune-up

**Details**

**Air Conditioner and Heat Pump High Performance Tune-up**

Content 7 Modules

Course Length 1 hour

Rating ★★★★★ 170 Reviews

Reviewer/Instructor Traci Synatschk

Enroll

**Reviews**

**RP Robert**  
★★★★★ · 20 Jan 2022

**PB Phil**  
★★★★★ · 19 Jan 2022  
I would like the calculations slides sent to me so I can see the math and show it

**WH Will**  
★★★★★ · 17 Jan 2022  
Good

**RW Rob**  
★★★★★ · 15 Jan 2022

**About**

Browse & Search the course catalog. Feel free to enroll in courses you are interested in.



**Drew Eckman**  
*Bluon*



**Clifton Beck**  
*Bluon*





Smart Diagnostic Tools | January 2022



**Drew Eckman**  
Senior Vice President



**Clifton Beck**  
Director of Training Content





# THE PROBLEM

HVAC units today are **severely** underperforming

## The Problem

HVAC Systems are running  
30% below\* their rated efficiency



\*National Institute of Standards and Technology (October 2014):  
*Sensitivity Analysis of Installation Faults*

## WHY?

Lack of Training &  
Improper Installations



- Improper refrigerant charge
- Incorrect airflow
- Oversized equipment
- Leaks



# THE LABOR SHORTAGE & SKILLS GAP IN HVAC



## HUGE Knowledge & Labor Gap

- Vast majority of new techs have no real training
- Historical mentor / apprentice approach is lost

## Technicians Drive Product Adoption

- Techs are driven by one thing: **EASE**
- Reluctance to try anything new or remotely risky

Labor  
Shortage

Skills Gap



Bottom Line: you need tech adoption and advocacy





# HOW DO YOU SOLVE THIS PROBLEM?

1

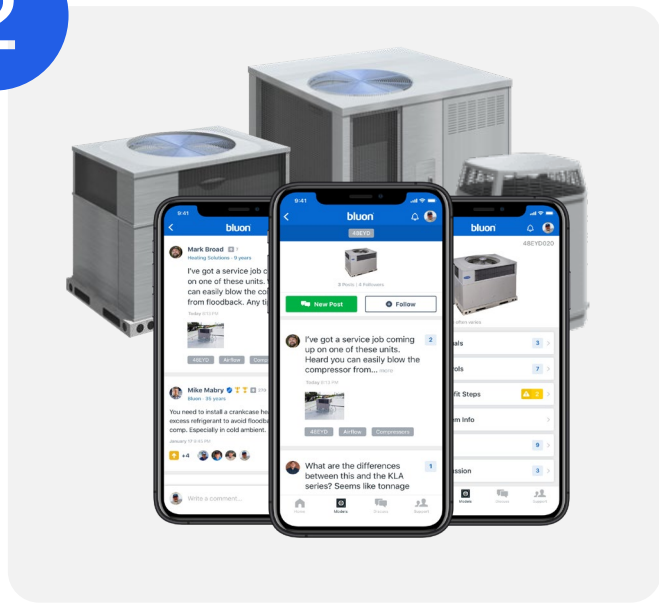


## Smart Tools

But these aren't new...

DONE

2



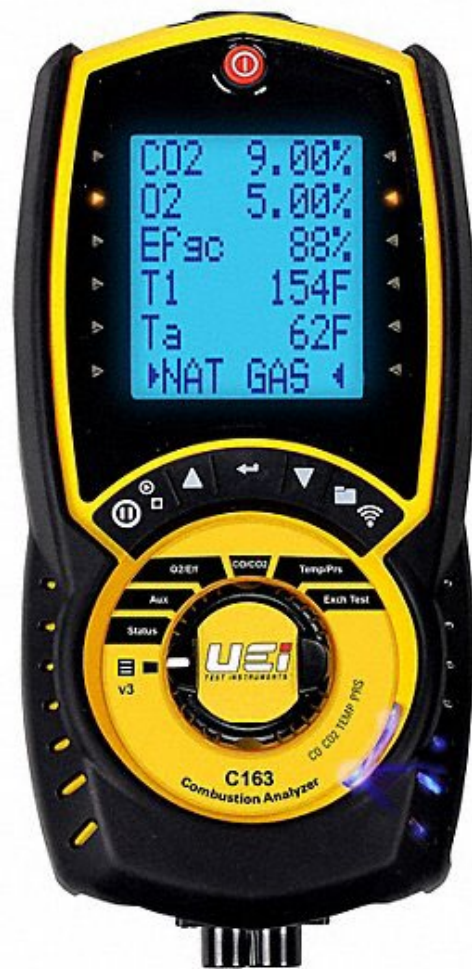
## Scalable Training

With software that complements tools

IN PROCESS



# SMART TOOLS





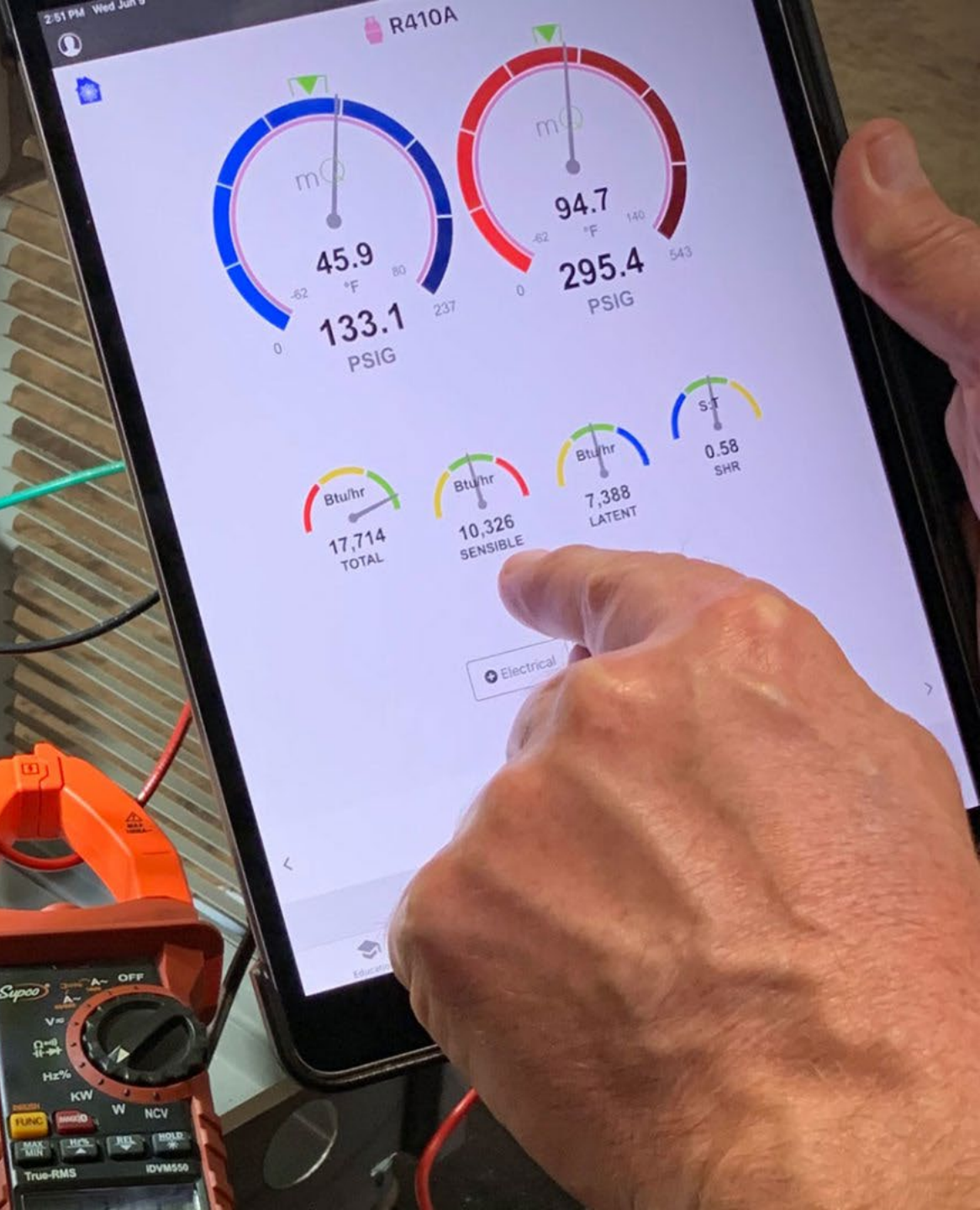
# SOFTWARE THAT COMPLEMENTS SMART TOOLS


















03678  
-018JAL  
Charge 22522  
Leak Test #1 20147  
Final Inspection 23824  
THE NEXT INSPECTOR  
IS OUR CUSTOMER  
60-16090-03-04







# SO WHAT ARE TECHNICIANS BUYING?

<div>#13</div> <div></div> <div>Mechanical Manifold Gauge Set, 2-Valve ★★★★★ 488 \$69.20</div>	<div>#14</div> <div></div> <div>Fieldpiece SM380V SMAN manifolds, Black ★★★★★ 257 \$503.41</div>	<div>#15</div> <div></div> <div>Orion Motor Tech AC Gauges and Vacuum Pump, 3 Way AC Gauge Set with 5FT Hoses,... ★★★★★ 40 \$110.99</div>	<div>#46</div> <div></div> <div>Uniworld G429ND 3-1/8" Red/High Pressure NPF® Gauge W/Boot, (PSI °F) (R410a/R22... ★★★★★ 7 \$21.40</div>	<div>#47</div> <div></div> <div>3-Way A/C Diagnostic Manifold Gauge Set Refrigeration Machine for Vacuum... ★★★★★ 25 \$39.99 - \$45.99</div>	<div>#48</div> <div></div> <div>Yellow Jacket 49997 Titan 4-Valve Test and Charging Manifold Degrees F, psi Scale, R-22/134A/404A Refrigerant, Liquid Gauges \$334.70</div>
<div>#16</div> <div></div> <div>Detool Adjustable R134A Adapter Fittings High-Low Quick Coupler AC Car Air... ★★★★★ 279 \$1.18?_encoding=UTF8&amp;psc=1&amp;refRID=HE...</div>	<div>#17</div> <div></div> <div>Yellow Jacket 49016 Class B Manifold Compound Gauge, 30 in HG to 120 PSI, 1/8... ★★★★★ 27 \$20.90</div>	<div>#18</div> <div></div> <div>Fieldpiece SM480V - Four Port, Wireless SMAN Manifold with Micron Gauge and Yellow... ★★★★★ 89 \$694.00</div>	<div>#49</div> <div></div> <div>Yellow Jacket 49832 Titan 2-V Charging Manifold Gauges R-134a/404A/407C ★★★★★ 19 \$142.10</div>	<div>#50</div> <div></div> <div>Fieldpiece SM380V - Three Port, Wireless SMAN Manifold with Micron Gauge and... ★★★★★ 10 \$566.75</div>	<div>43 out of the top 50</div>



WHY ARE THEY NOT BUYING SMART TOOLS?

# Lack of Proper Training And Support







# BLUON SUPPORT PLATFORM

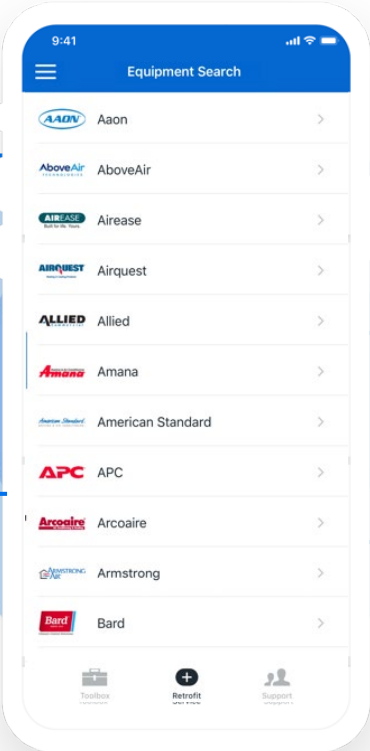


Download  
the Bluon App

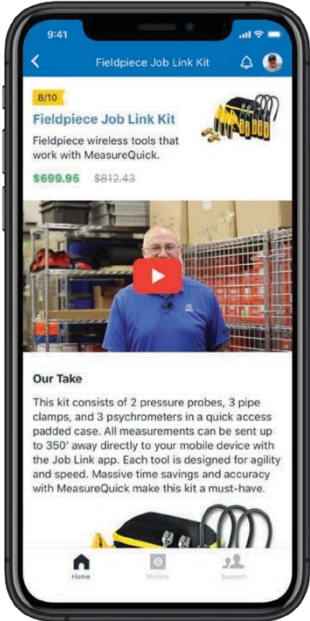
ORIGINAL  
MANUALS



OVER 50,000 UNITS

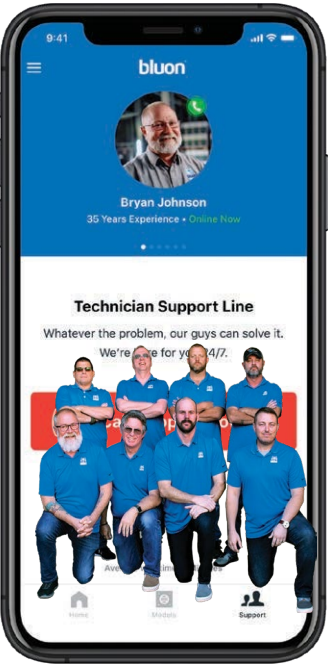


TRAINING VIDEOS  
BEST PRACTICES

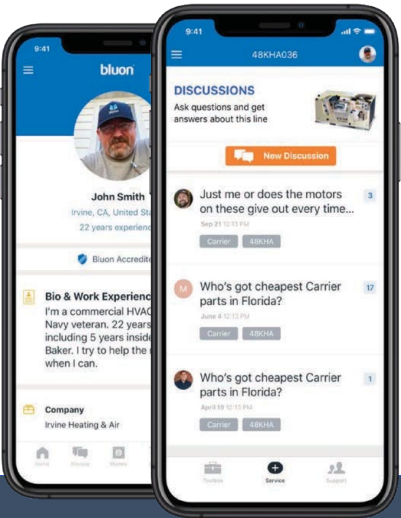


Real  
Tech

24/7 SUPPORT –  
2 MIN WAIT TIMES



TECHNICIAN  
FORUM





# A LITTLE SUPPORT CREATES MASSIVE IMPACT



70% Efficient



Techs with no support leave systems at **low efficiency**



80% Efficient



Techs with basic Bluon support leave systems @ **80%+ efficiency**



**Easily Achievable!**



95% Efficient



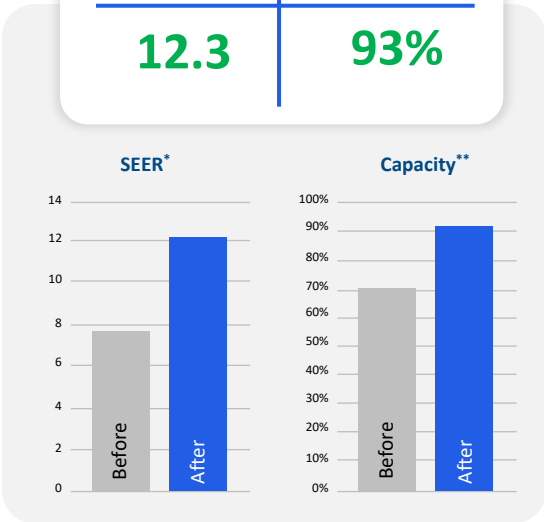
Techs w/ Bluon support + digital gauges leave systems **near optimal**



# IMPACT OF TRAINING & SUPPORT

290 Units in Plano, TX

SEER	Capacity
7.9	71%
12.3	93%

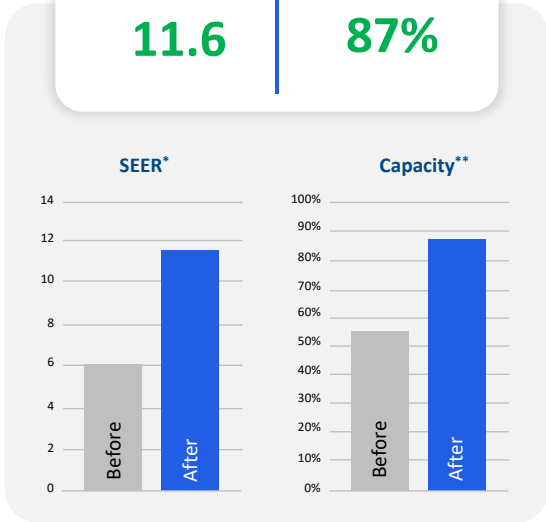


1,160 MTs

Yearly Reduction of CO<sub>2</sub>  
Metric Tons

200 Units in Euless, TX

SEER	Capacity
6.0	55%
11.6	87%

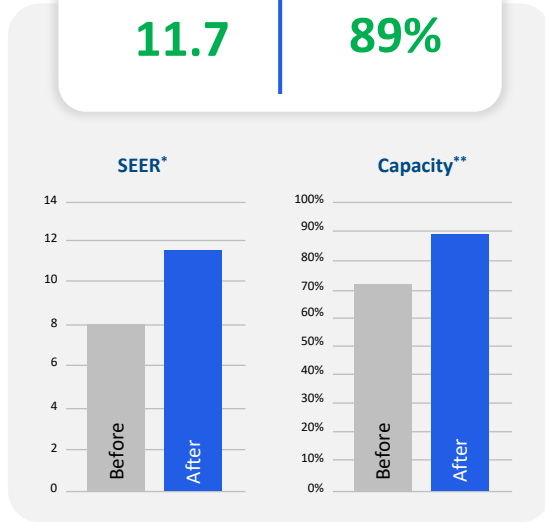


1,000 MTs

Yearly Reduction of CO<sub>2</sub>  
Metric Tons

250 Units in Allen, TX

SEER	Capacity
8.1	72%
11.7	89%

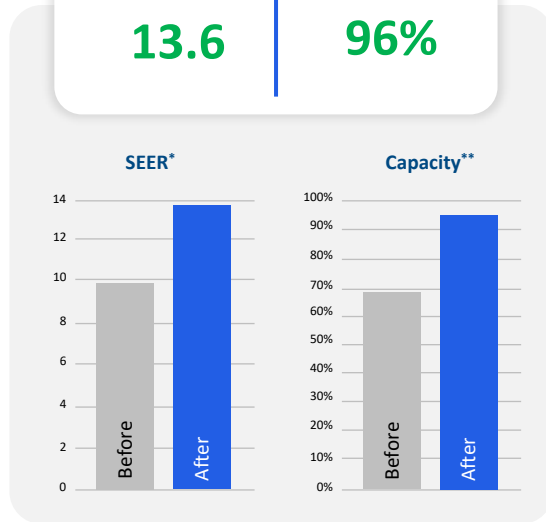


1,000 MTs

Yearly Reduction of CO<sub>2</sub>  
Metric Tons

185 Units in Richardson, TX

SEER	Capacity
9.7	70%
13.6	96%



740 MTs

Yearly Reduction of CO<sub>2</sub>  
Metric Tons



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**Drew Eckman**

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502.797.2985



**Clifton Beck**

Director of Training Content  
[cbeck@bluon.com](mailto:cbeck@bluon.com)  
317.960.4278

# Explore the Residential Program Solution Center

Resources to help improve your program and reach energy efficiency targets:

- [Handbooks](#) - explain *why* and *how* to implement specific stages of a program.
- [Quick Answers](#) - provide answers and resources for common questions.
- [Proven Practices](#) posts - include lessons learned, examples, and helpful tips from successful programs.
- [Technology Solutions](#) **NEW!** - present resources on advanced technologies, **HVAC & Heat Pump Water Heaters**, including installation guidance, marketing strategies, & potential savings.



<https://rpssc.energy.gov>

# DOE Health + Home Performance Infographic

- **WHO**: Res EE programs, partners (contractors+)
- **WHAT**: Visual aid, trusted source
- **WHERE**: IRL or digitally
- **WHY**: Most do not get link btw home, health & efficiency
- **CONTRACTORS**: Find qualified networks

## Do You Have a “Healthy Home?”

A qualified contractor can help you assess and address indoor air quality, improve your comfort, and cut your utility bills.

Answers to a few basic questions can help you get started:

- **How old are your heating and cooling systems?**

Ensuring your system is updated and well maintained can save money and improve health and comfort.

- **Is your home insulated?**

Properly installed insulation in your walls and attic, at levels recommended for your home's climate, will cut bills, and improve comfort.

- **Have you ever noticed mold in your home?**

Visible mold likely means humidity levels need to be better addressed or indicates a potential leak or water damage.

- **Are your windows caulked and doors weather-stripped?**

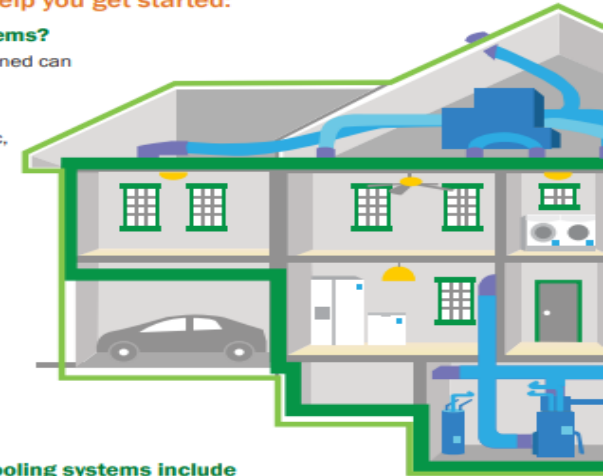
These relatively simple fixes reduce air leaks and help maintain indoor temperature levels.

- **Are your appliances ENERGY STAR® rated?**

ENERGY STAR appliances are energy efficient and help you save money.

- **Do you know if your home's heating and cooling systems include proper levels of ventilation?**

Effective ventilation is important for both health and safety. Ventilation, along with frequently replaced air filters, can help make sure your home is bringing in fresh air as needed, and keep out pollutants when outdoor air quality is poor due to ozone, fire, or other factors.



### GET started

#### FIND A QUALIFIED CONTRACTOR:

- Home Performance with ENERGY STAR® at [ENERGYSTAR.gov/HomePerformance](https://energystar.gov/HomePerformance)
- Building Performance Institute at [bpi.org/locator-tool](https://bpi.org/locator-tool)

U.S. DEPARTMENT OF  
**ENERGY** | Office of ENERGY EFFICIENCY  
& RENEWABLE ENERGY  
BUILDING TECHNOLOGIES OFFICE

DOE/EE-2349



# Thank You!

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[Office of Energy Efficiency and Renewable Energy Facebook](#)

Please send any follow-up questions  
or future call topic ideas to:  
[bbresidentialnetwork@ee.doe.gov](mailto:bbresidentialnetwork@ee.doe.gov)